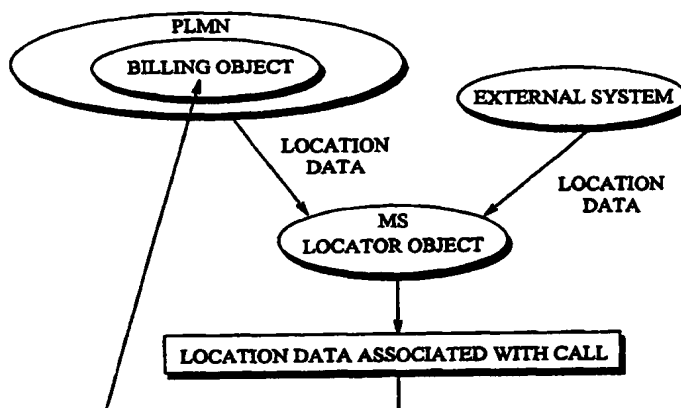




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(21) International Application Number: PCT/FI98/00515 (22) International Filing Date: 15 June 1998 (15.06.98) (30) Priority Data: 972591                      17 June 1997 (17.06.97)                      FI (71) Applicant (for all designated States except US): SONERA OY [FI/FI]; Sturenkatu 16, FIN-00510 Helsinki (FI). (72) Inventor; and (75) Inventor/Applicant (for US only): LINKOLA, Janne [FI/FI]; Oikokatu 9 A 3, FIN-00170 Helsinki (FI). (74) Agent: PAPULA REIN LAHTELA OY; Fredrikinkatu 61 A, P.O. Box 981, FIN-00101 Helsinki (FI).		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i> <i>In English translation (filed in Finnish).</i>	

(54) Title: CHARGING METHOD IN A MOBILE TELECOMMUNICATION SYSTEM



## (57) Abstract

The charging principles regarding mobile calls can be improved by providing the mobile station with a locator object, which at certain intervals determines the cell in which the mobile station is currently located. Stored in the mobile station is also a list of areas permitting application of a special rate. The locator object monitors calls made from the mobile station. When it detects that a call is being started, it checks whether the mobile station was in a special rate area at the time when its location was determined last. If this is the case, then the object will inform the network that the call is entitled to a special rate. As the last location function was executed just before the call setup was started, a special rate call is possible even if the mobile station has moved some distance into the area of a cell applying a normal rate. Placed in a billing centre is a billing object, to which the locator object sends data indicating whether the call was started from a cell or area where a special rate is applicable, as well as data identifying the call. The second object receives the billing records generated by the mobile switching centre, which also contain call identifying data, and compares the call-specific data in them with the data sent by the first object. In this way, the second object can find from the billing records the calls that are entitled to a special rate, regardless of whether the mobile station has moved during call setup from the original cell into a cell where another rate, e.g. a higher rate is applicable.

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## CHARGING METHOD IN A MOBILE TELECOMMUNICATION SYSTEM

### SCOPE OF THE INVENTION

The present invention relates to the formation of the principles of calculation of call price in a cellular mobile communication system.

### TECHNOLOGICAL BACKGROUND

In a wired network, the charge for a call depends on whether the call is a local call, a trunk call or an international call, in other words, a geographically defined call, or whether it is a call to a service number. Thus, when dialling the number of a called subscriber, the calling subscriber already knows the principles on which the price of the call will be calculated.

The principles used in a wired network for calculating the call price cannot be directly applied in mobile telephone networks. This is because the mobile subscriber is not tied to a given locality while the called subscriber may be a locality-dependent wired network subscriber or a mobile subscriber in the same mobile communication network or a subscriber in another operator's mobile communication network. Within the mobile communication network, no distinction is made between local calls and long-distance calls regarding pricing; moreover, in distinction from the wired network, even the called subscriber is liable to pay a portion of the price of a received call in certain cases.

In mobile communication networks, a difficulty in locality-dependent determination of price is that the exact locality of neither the calling nor the called subscriber is known. To give an understanding of the principles of calculation of call price, the

call setup process in a mobile communication network will now be described in general outline, referring to Fig. 1.

When a calling subscriber in cell a1 in location area 1 under mobile switching centre MSC1 makes a call to a subscriber in location area 2 under another mobile switching centre MSC2, he/she will dial the MSISDN number (Mobile Subscriber International ISDN number) of the called subscriber on his/her mobile station MS-A, which sends it in a message to the base transceiver station 1, step 1. Upon receiving the message, MSC1 checks whether the request can be accepted. As a part of this check, the subscriber data of the calling subscriber are retrieved from the visitor location register VLR1 associated with MSC1, where they have been stored in conjunction with the location updating procedure. If the request is accepted, the mobile switching centre MSC1 will send to the home location register HLR an enquiry containing the called subscriber's MSISDN number, step 2. Based on this number, the HLR retrieves the data for the called subscriber, which indicate that the called subscriber has roamed to visitor location register VLR2. Next, the HLR sends the IMSI (International Mobile Subscriber Identity) data to visitor location register VLR2, asking the latter to give the roaming number, step 3, whereupon VLR2 sends the roaming number MSRN to the home location register HLR, step 4, from where it is sent further to MSC1, step 5.

After this, the call can be routed from mobile switching centre MSC1 to mobile switching centre MSC2 on the basis of the MSRN number (Mobile Subscriber Roaming Number) received from VLR2, step 6. Upon receiving the start message, the mobile switching centre MSC2 of the called subscriber retrieves the subscriber data for the called subscriber from the associated VLR2. From the subscriber data, MSC2 learns

the location area LAI 2 of the called subscriber, so MSC2 is able to send a paging message via the appropriate base station controller 2 (step 7) to the cells b1, b2, b3 in the location area in question. After the called subscriber's mobile station MS-B has responded to the paging, the call is finally set up to the called subscriber. From what was said above, it is obvious that it is only after the called subscriber's mobile station has responded to the paging message that the relevant mobile switching centre MSC2 is informed of the called subscriber's location at the cell level.

The mobile switching centre may also be linked to a service switching point SSP of an intelligent network IN to allow connections from the mobile communication network to the intelligent network. Via an intelligent network, a wide variety of services can be offered to the subscribers of the mobile communication network, including services like follow-me-diversion of calls, call rerouting distribution, premium rate calls, etc.

In a state-of-the-art mobile communication network, the main rule regarding call charging is that the calling subscriber is charged for the connection between him/her and the home network of the called subscriber while the called subscriber is charged for the connection between his/her current locality and his/her home network.

To increase flexibility regarding the billing principles, a known method is to set a special billing parameter that allows calls made from the subscriber number associated with the parameter to be billed at a rate lower than normal at times when the load on the mobile communication network is low and, correspondingly, at a higher rate when the load on the mobile communication network is high. This parameter creates a time-dependent call charging principle, but in other

respects the pricing of calls follows the above-mentioned principles. Another known practice is to charge a lower price for calls between a mobile station and a specified wired network telephone than for  
5 normal calls. This can be implemented by assigning for all subscribers to the service a common service number, e.g. 020100, as the called subscriber number, which directs the call to an intelligent network. In the intelligent network, a service program searches a  
10 database to find the called subscriber number associated with the calling subscriber number, and the call is routed to this number.

A comparison of the principles of call price calculation used in mobile communication networks with  
15 those used in wired networks reveals certain problems. Since all cells are equal with respect to the mobile communication network, it is difficult to offer the various user groups any other principles of call price calculation than e.g. the aforesaid price variation  
20 based on the time of the day. At present, there are no special call price calculation principles applicable to calls within the same cell or calls between certain cells. However, it would be attractive for a mobile telephone network operator to be able to provide vari-  
25 ous services dependent on the locality where the call is started and/or where it is terminated. Such services include e.g. locality-dependent pricing solutions.

Specifications WO-96/20570 and WO/96/20571  
30 present solutions for determining the principles of call price calculation. The price calculation principles can be improved by setting a given cell or a number of cells of a mobile telephone network as a special cell group. During call setup, the mobile switching centre or a service control point SCP in an intel-  
35 ligent network analyses the call to determine whether the cell in whose area the calling subscriber is lo-

cated and/or the cell in whose area the called subscriber is located belong(s) to the group of special cells. When the calling and called subscribers are located in cells belonging to different switching centres, data regarding the cell of the called subscriber is transmitted to the switching centre of the calling subscriber or to an intelligent network before a voice connection is established. Thus, based on whether the subscribers are in a group of special cells or not, it is possible to vary the call charging rates applied.

Specification WO-96/34499 describes a system in which the subscribers are divided into normal subscribers and "fixed" subscribers. A normal subscriber may start a call in any cell, whereas a fixed subscriber has limited access to the network from a subscriber area comprising one or more cells. When a fixed subscriber is at the boundary of his/her area, the call is forcibly directed to the base transceiver station of the subscriber area if possible.

These solutions allow the application of more fine-grained call charging principles than those generally used. A feature common to these solutions is that the right to a differently priced call is determined according to the cell in whose area the subscriber is physically located at the time of the call, i.e. according to the base transceiver station that connects the subscriber to the network. This is because the metering record generated at the start of the call includes, among other data, an identifier of the base transceiver station via which the connection is set up, and the base station identifier again reveals whether the base station belongs to a group of special cells. In other words, the base station identifier functions as a factor that ultimately determines the price of the call.

However, there is a problem associated with these prior-art solutions. In most mobile telephone

systems, it is the network that makes the decision as to which base station is to be used to transmit the subscriber's calls. When the subscriber is in the fringe area of a cell where a lower call charge is applicable, the network may repeatedly command the mobile station to perform a handover between two base stations, which means that the calling end of the connection alternates between the base station of a "cheaper" cell and the base station of an adjacent cell. It the adjacent cell is not one of the cells where a lower call charge is applicable, then the result would be that the call price would vary during the same call as the connection is handed over from one base station to another, the call charge being thus lower at one moment and higher at the next, without the subscriber having any chance to influence the situation in any way.

One solution proposed to cope with this problem is to give the mobile station some of the handover control functions between base stations. In the idle state, the mobile station would remain as long as possible in signalling contact with a cell applying a lower call charge when in the fringe area of the cell, in other words, the mobile station would remain "hanging" in the cell even when a neighbouring cell would provide a better connection quality. During a communication connection, too, the mobile station would continue hanging in the old cell when in the area of another cell, and it would inform the network e.g. in conjunction with a change of base station or the call setup procedure that it gives preference to the old base station providing cheaper service instead of other base stations.

However, this solution has the drawback of increased co-channel interference, which is due to the fact that, when the communication connection is forcibly maintained via the base station of a cheaper cell

although the mobile station is located in the area of an adjacent cell that would provide a better connection, the mobile station has to use a higher transmission power to compensate for the signal attenuation caused by the longer distance. Therefore, the mobile telephone interferes with other mobile stations using the same frequency that are communicating at the reuse distance of this frequency. Another drawback is that changes need to be made in certain network components, such as the base station controller and the telephone itself. Changes must be made at least in the handover criterion and algorithm.

Another solution proposed to deal with the problem is to have information presented on the display of the mobile station in the idle state to indicate the cell in whose area the mobile station is currently located. The idea is to allow the subscriber to move into the area of a cell with a lower call charge at least when the subscriber is at the boundary between cells. A drawback with this solution is that, as the billing record is generated at the beginning of the call when the telephone is already in the active state, the subscriber may move on to the area of a cell with a higher call charge during the call setup procedure although the subscriber has seen from the display before the transmission of the call setup request that the mobile station is still located in the area of a cheap cell.

The object of the present invention is to achieve a system that is free of the drawbacks of prior-art systems and that does not produce co-channel interference. In the system, determination of location of a mobile station should be implemented in a manner that allows a call started from a special cell to continue being charged at the rate applicable in that cell even if the mobile station should move on to a cell with a normal charging rate during call setup. A

further object is to ensure that, even if call setup is started in a cell with a normal charging rate but a moment earlier the mobile station has been in a special cell, the call can still be charged at the rate applicable in the special cell. The length of time of the moment should also be adjustable.

Yet another object is to achieve a system in which the area of a specially priced call is not dependent on the cell coverage area but may consist of any geographic area. The area may even consist of a part of one cell and a part of another cell. Location of the mobile station should therefore be independent of the information transmitted by the base stations.

The objects stated above can be achieved with the attributes defined in the independent claims.

#### SUMMARY OF THE INVENTION

According to the basic idea of the invention, the mobile station is provided with a first object, a locator object, which determines the location of the mobile station. The location function can be carried out with an accuracy of a cell or a sub-area of a cell, making use of the existing properties of the mobile communication system. By utilising location methods external to the mobile telephone system, completely cell-independent location can be achieved. The location function is executed at certain intervals. The mobile station also contains a stored list of cells and/or areas where a special charging rate is applicable. The locator object monitors the calls originated from the mobile station. When it detects that a call is being started, it checks whether the mobile station was in a cell or area with a special charging rate at the time when the location function was executed last. If this is the case, then the object will inform the network that the call is entitled

to a special rate. The last location function has even been executed before call setup is started, so a call chargeable at a special rate is possible even if the mobile station has moved some distance into the area of a cell applying a normal rate. Channel allocation is done independently of location in accordance with the normal procedures in the system, which means that co-channel interference is avoided.

One of the network elements is provided with a second object, a billing object, to which the first object sends information indicating whether the call has been started from a cell or area where a special rate is applicable. The second object receives the billing records generated by the mobile switching centre and compares the call-specific data in them with the data sent by the first object. In this way, the second object can find those calls in the billing records that are entitled to a special rate, even if the mobile station has moved during the call setup from the original cell or area into a cell where another rate, e.g. a higher rate is applicable.

Cells allowing the application of a special rate can be divided into groups of cells or areas, and each of the groups may have a different rate applicable in that group. Thus, when the final telephone bill is being compiled, the rate applicable in the special rate group can be checked and the call charge can be determined accordingly.

The locator object may send the data regarding a call entitled to a special rate to the network during the call or alternatively it may collect such data for a desired length of time and send the data at once to the billing object. However, the latter method has the drawback that it leads to a more difficult generation of the telephone bill if the data are received after the call records received during the billing period have been subjected to post-processing.

**LIST OF FIGURES**

A preferred embodiment of the invention is described by referring to the attached figures, of which

5

Fig. 1 illustrates call setup in a mobile telephone network,

Fig. 2 illustrates the principle of the invention in a simplified form,

10

Fig. 3 illustrates the system in a mobile telephone network, and

Fig. 4 presents a flow and signalling diagram consistent with the procedure, applied to a known mobile telephone system.

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**DETAILED DESCRIPTION OF THE INVENTION**

Fig. 2 illustrates the principle of the invention in a simplified form. A mobile telephone system PLMN (Public Land Mobile Network) 22 is provided with a billing object. It is placed in a network element where call data are collected in a centralised manner for billing purposes, so a natural place for it is the billing centre, to which the mobile switching centres send their call data records. Installed in the mobile station, i.e. mobile telephone MS, is a locator object 21, whose function is to establish the location of the mobile station and to send the location data to the billing object 22.

The locator object receives the information required for the determination of location in two ways: either from the mobile telephone network PLMN or from an external system.

The first-mentioned method is based on the fact that the base stations in all known mobile telephone networks transmit information about themselves in a signal that, depending on the system, can be

called e.g. a beacon signal, a broadcast signal, a pilot signal, or using a corresponding designation. From this signal, the locator object can easily determine its location at least with an accuracy of one cell. In some countries, the regulations by authorities stipulate mobile station location determination with an accuracy beyond the level of the cell coverage area. To meet this requirement, several different methods have been proposed, such as methods based on a timing advance. In these, the network measures timing advance values between several base stations and the mobile station, and since the timing advance between the mobile station and each base station is directly proportional to the distance, three timing advance values will be sufficient to produce coordinates defining the location of the mobile station with a reasonable accuracy. If the PLMN network computes the location data, then these data are transmitted to the locator object.

The second method is based on the principle that the mobile station determines its location in a manner independent of the PLMN network by using some external system. Such a system could be e.g. the previously known GPS (Global Positioning System) satellite location system. In this case, the locator object would contain a GPS receiver.

In both methods, the location data is transmitted during or after the call to the billing object, which uses it as a basis for calculating the charge for the call.

Next, a description will be given of how the invention is applied in the previously known GSM system.

Fig. 3 presents the essential parts of the system, complemented with objects according to the invention. Many of the network elements have already been described in conjunction with Fig. 1. In the state-of-the-art system, when a mobile station MS ini-

tiates a call, the mobile switching centre MSC generates a call data record CDR, in which a desired amount of information relating to the call is stored. Usually this information comprises at least the call start  
5 time, termination time, calling and called numbers and a cell identifier Cell ID. The mobile switching centre MSC transmits a large number of CDR records at a time to the billing centre, where a billing program post-processes the call data records and generates the  
10 bills to be sent to the subscribers.

In the GSM system, as in other modern systems, the mobile station MS actually consists of two parts: mobile equipment ME and SIM card (Subscriber Identity Module), so a workable mobile station MS is  
15 only obtained by inserting a SIM card into the mobile equipment ME. The SIM card can be used as a storage medium for storing telephone numbers, but above all it is used for subscriber authentication. Identification based on the SIM card inserted by the user into the  
20 mobile station MS is designed to prevent illicit use of e.g. stolen equipment and to ensure that only subscribers who pay their bills can use the network. Stored on the card are a user identifier, i.e. PIN code (Personal Identity Number) as well as a sub-  
25 scriber identity code IMSI to be used in the network, the identification algorithm A3 to be used in the authentication and a subscriber-specific identification key  $K_i$ .

According to the invention, the mobile station MS is provided with a new function, which in this  
30 context is designated as locator object, Fig. 3. The function of the locator object is to establish whether the mobile station is in an area where the charging rate applied to calls originated from that area are  
35 different from the rate for calls made from other areas. Usually the rate is lower. For this purpose, the locator object needs to know the location of the mo-

bile station. In the determination of location, the broadcast information sent by the base transceiver stations is utilised. The base transceiver stations keep on sending information about themselves and their environment in their broadcast control channel. This information includes a cell identity code CI, information about adjacent cells and a location area identifier LAI. In its idle state, according to the specification, the mobile station performs frequency measurements on the BCCH (Broadcast Control Channel) channels. From a certain number of BCCH signals, e.g. six signals of highest strength, it decodes the BCCH data block, from which it obtains the BSIC data (Base Transceiver Station Colour Code). Each signal contains a cell identity code CI. The cell identity code and the carrier frequency form a pair that is individual to each base transceiver station. The one of the base transceiver stations that sends the BCCH frequency with the highest signal strength is regarded by the mobile station as its "own" base station. If the mobile station MS detects upon a change of base transceiver station BTS that the location area identifier LAI has changed, then it will send a location update request to the network.

Instead of the actual cell identity code CI, the location data used may consist of almost any unambiguous code obtained from the BSIC and updated at  $\frac{1}{2}$  second intervals that allows identification of the network cell or cell area. Such codes include the components of the world-wide CGI identifier (Cell Global Identification), which, according to the GSM recommendations, comprise a Mobile Country Code MCC, a Mobile Network Code MNC, a Location Area Identifier LAI and the above-mentioned Cell Identity code CI.

From the data listed above, a desired item can be selected to be used as the location data monitored by the locator object, so the area permitting

calls at a special charging rate can be defined as the entire network of the operator, as a location area or as a group of one or more cells.

The locator object picks the location data  
5 decoded by the mobile equipment and stores it in memory. The picking frequency may be the same as the frequency at which the identifiers are decoded, but since the mobile station cannot advance a long way in half a second, it is preferable to use a lower picking frequency.  
10 A suitable frequency is about once in a minute. This length of time is such that the mobile station may start a call setup process in one cell, whose base station identifier it has decoded, but the call setup process is terminated in another cell, whose  
15 base station identifier is decoded and placed in the call data record to be generated.

Stored in the memory of the locator object is a list of location data for cells permitting special call charging rates. The locator object compares the  
20 decoded location data it has picked with the stored data, and if the location data is found in the storage, then the object may give a command to display the data on the display of the equipment. It may display the cell identity code as it is or it may display e.g.  
25 a text saying "special cell" or the like to indicate to the user that calls in the current location area are cheaper. If the decoded location data cannot be found in the storage, this means that calls in the location area are charged for at normal rates, so there  
30 is no need to display any information. In this case, a list of special cells has been stored in the memory of the locator object and the locator object compares the located cell identity code with the identifiers in the list, and when this comparison indicates sameness, the  
35 above-mentioned texts are displayed.

When the locator object detects that the user is entering a telephone number and that the last loca-

tion check indicates that the mobile station is currently in an area where a special charging rate is applicable, it creates a record of the call data record type, which is designated here as compensation record.

5 The compensation record contains the location data either as such or preferably as a suitable code. Moreover, it contains at least the calling and the called subscriber numbers.

The locator object transmits the compensation record in a special call data message to the billing object 22 in the network, Fig. 3. The billing object is located in the billing centre. The compensation record may be transmitted either during the call or after the call. The locator object may also collect compensation records for a longer time and send the collected compensation records periodically to the billing object. The billing object gathers the call data records sent by the mobile switching centre and the compensation records sent by the locator object and

10 15 20 finds the ones of the call data records that are entitled to a different (lower) call charge even if the cell identity code in the call data record should indicate that the call is a normal rate call.

The locator object can be implemented as follows:

25

In the so-called Phase 2+ of the follow-up specification of the GSM system by ETSI (European Telecommunications Standards Institute), the functions of the SIM card have been considerably increased as compared with the original specifications. The new definitions are presented in detail in specification GSM 11.14 "Digital cellular communications system (Phase 2+): Specification of the SIM Application Toolkit for the Subscriber Identity Module-Mobile

30 35 Equipment (SIM-ME) Interface. It defines mechanisms that allow applications on the SIM card to cooperate and work with any mobile equipment ME that supports

these functions. The features that can be utilised in the implementation of the invention include Proactive SIM, which provides mechanisms by means of which, upon initiative by the SIM card, the mobile equipment performs certain functions, such as sending a message of max. 160 characters from the SIM card and displaying it, sending an USSD string (Unstructured Supplementary Service Data) to the network. An important feature in respect of the invention is the Call Control by SIM function described in section 9 in the specification. When this function has been activated on the SIM card, the mobile equipment ME will perform the following functions:

- During each call attempt, the mobile equipment transfers the numbers dialled by the user as well as the associated parameters to the SIM card. The only exception is a redialled attempt, of which only certain details of call setup are transferred to the SIM card.

- The SIM gives a certain response to the mobile equipment, according to which the mobile equipment either starts call setup in accordance with the numbers dialled, does not start call setup at all or uses the data given by the SIM in the call setup procedure.

- If an extra service function is in use, the mobile equipment ME transfers a service control string to the SIM card before the service is implemented.

- The SIM gives the mobile equipment a response of the same type as in the case of dialled numbers, whereupon the mobile equipment either starts the service or does not start it or starts it in accordance with the instructions given by the SIM card.

Moreover, section 6.4.15 of Phase 2+ defines the command PROVIDE LOCAL INFORMATION, which the SIM can use to request the mobile equipment to send current location information. When the SIM issues this

command to the mobile equipment, the latter responds by giving a TERMINAL RESPONSE, which contains the Mobile Country Code MCC, Mobile Network Code MNC, Location Area Identifier LAI and the Cell Identity code CI.

In addition, Phase 2+ defines the command DISPLAY TEXT. By giving this command, the SIM can cause the mobile equipment to display a desired text on the display of the equipment.

These new features of the SIM-ME interface as defined in Phase 2+ are preferably utilised in the implementation of the invention. Referring to Fig. 4, the operation of the locator object will now be described by using the concepts mentioned above. The figure illustrates the functions of the locator object and the messages exchanged between the SIM card, the mobile equipment ME and the base transceiver station BTS.

The locator object, which is a suitable program, is implemented on the SIM card. At regular time intervals  $\Delta T$ , the object sends a PROVIDE LOCAL INFORMATION message to the mobile equipment ME. In response to this message, the mobile equipment sends a TERMINAL RESPONSE message, which contains the mobile country code MCC, mobile network code MOBILE NETWORK CODE MNC, location area code LAC and the cell identity code CI (Cell Id). Let us suppose that the object uses the cell identity code CI as location data. Upon receiving the message, the locator object checks whether the cell identity code is included in the list stored on the SIM card. The list has been stored on the card beforehand by the network operator. If it is not found in the list, then the cell identity data last saved is reset and, after the set time interval  $\Delta T$ , the locator object sends a new request for location data and again compares the cell identity code received with the

list. But if the cell identity code is found in the list, this means that the mobile equipment has received location data from the BCCH carrier while in a cell for which the operator has set a special charging rate for calls originated from that cell. In this case, the location data is stored in memory. Again, after an interval of  $\Delta T$ , a request for location data is sent and the above-described procedure is repeated. If the cell identity code is not found in the list, then the previously stored cell identity code is reset.

When the location data has been stored, the locator object sends a DISPLAY TEXT message to the mobile equipment, which then displays the cell identity code comprised in the message either as it is or in plain-language form, e.g. "Reduced call charge" or the like.

When the user dials a telephone number to make a call, the mobile equipment transfers the called number dialled by the user in an ENVELOPE message to the SIM card. If the locator object accepts the number, it will send an ALLOWED acknowledgement message. After this, call setup proceeds in the normal manner and ends with a CONNECT message sent by the network, whereupon the speech path is connected. In response to the CONNECT message, the mobile equipment sends a TERMINAL RESPONSE message to the SIM card, letting the locator object know that the speech path has been connected.

The locator object now retrieves the location data from the storage. If it is not zero, which would mean "not a special rate cell", the locator object will start generating a compensation record by placing in the record the location data and call identification data specifying the call so that the billing object will be able to link the compensation record and the call data record generated by the mobile switching

centre together. The call identification data may include at least a running sequence number N, which is reset when it reaches a maximum value M. The sequence number thus changes as moduloM. Each successful call would thus be given a sequence number, but since a compensation record is not generated for every call, the locator object will receive compensation records with a sequence number N that does not grow regularly. For this reason, the mobile switching centre must be provided with a function that adds to the call data record a sequence number N increasing in the same way moduloM. Thus, the billing object will be able to link the compensation records with call data records having the same N value and charge the customer on the basis of the location data given in the compensation record. Of course it is also possible to include the calling and the called numbers in the compensation record.

During the call, the locator object transfers the compensation record to the mobile equipment, which sends it over the network to the billing object during the call. The transmission can also be effected in the form of a short message SMS (Short Message Service), in which case the locator object will give the mobile equipment a Send SMS command, or using the USSD (Unstructured Supplementary Service Data) consistent with the GSM standard, in which case it will give a Send USSD command.

In the foregoing description, the compensation record was sent during the call. As another alternative, the locator object may collect compensation records for some time and send them to the billing object in a larger batch. The limit for the batch size is set by the maximum length of the short message, which is 160 characters. The transmission of the batch can be done in the same way as the transmission of a compensation record during a call. However, if the compensation records are not sent during the call but

periodically in larger batches, there is a risk that the compensation records associated with the calls will be received after the actual billing period. This would be difficult because it would be necessary to  
5 send credit notes to the customers. Therefore, real-time transmission of compensation records is a preferable alternative.

In both alternatives, the billing object gathers the call data records sent by the mobile  
10 switching centre and the compensation records sent by the locator object together and finds those ones of the call data records which, according to the compensation record, are entitled to a different (lower) call charge, even if the cell identity code in the  
15 call data record should indicate that the call is a normal rate call. If the billing object cannot match a call data record produced by the mobile switching centre with a compensation record produced by the locator object, then it will assume that the call has been  
20 made in a normal rate area.

For the transmission of the compensation records to the billing object, a reliable data transmission link must be available between the objects. The SMS and USSD used in the GSM system are sufficiently  
25 reliable for this purpose.

The invention is not restricted to the example presented in the foregoing, but many different embodiments are possible within the scope of the definitions given in the claims. The locator object may also  
30 be implemented in the mobile equipment while only a list of special cells is stored on the SIM card by the operator.

Besides the cell identity code CI, the data used as location data may consist of the mobile country code MCC, the mobile network code MNC or the location area code LAC or a combination of these. In the  
35 CDMA system, the base station pilot signal data can be

used as location data because each base station keeps sending its own individual pilot signal. If the mobile communication system comprises, e.g. because required by the authorities, a feature for calculating the location of the mobile station using timing advance values or some other method, then this information is transmitted e.g. in the form of coordinates to the locator object. In this case, the locator object can be provided with tables of special location areas, whose boundaries need not coincide with cell area boundaries. The tables contain e.g. coordinate values and the locator object compares the current location data with the table to establish whether the location is within a special area. It is also possible to provide the mobile station with a location system such as a GPS receiver. The locator object compares the coordinate values obtained from the system with the table values and proceeds as above.

## CLAIMS

1. Procedure for forming the principle of calculation of call charge in a cellular mobile telephone network, which comprises
- 5           a mobile switching centre, which produces a call data record for each call,
- and a plurality of base transceiver stations, each of which transmits the calls of the mobile stations located in the area served by the respective
- 10   base transceiver station,
- and in which at least one special area has been formed and a special charging rate has been set for calls originated from such an area, and in which the mobile station determines its location at time intervals of a predetermined length,
- 15           characterised in that
- a list of the location identifiers of the special areas is stored in the mobile station in advance,
- 20           and that in the mobile station;
- a check is carried out to establish whether the location data of the mobile station is comprised in the special areas on the list,
- the location data is stored in memory for
- 25   said time interval of predetermined length if it is comprised in the list,
- a compensation record associated with a call initiated from the mobile station is generated during the call if the location data has been stored in memory, the information placed in said compensation record comprising at least the location data and data
- 30   identifying the call,
- the compensation record is transmitted to the mobile telephone network,
- 35           and that in the mobile telephone network;

to determine the charge for the call, the data in the compensation record and the data in the call data record are combined.

2. Procedure as defined in claim 1, characterised in that the determination of location is effected by utilising identifier data sent by the mobile telephone network.

3. Procedure as defined in claim 1, characterised in that the determination of location is effected by utilising data sent by an external system.

4. Procedure as defined in claim 3, characterised in that the external system used is a satellite positioning system.

5. Procedure as defined in claim 1, characterised in that the data identifying the call is a parameter placed in both the compensation record and the call data record, being the same in both records.

6. Procedure for improving the principles of calculation of call charge in a cellular mobile telephone network, in which

the mobile stations order the broadcast channels received from different base transceiver stations according to signal strength and decode at least from the strongest broadcast channel the various identifier data sent by the base transceiver station,

at least one special area has been formed and a special charging rate has been set for calls started from such an area, and

the mobile station determines its location at time intervals of a predetermined length,

characterised in that

a list of special areas is stored in the mobile station,

and that in the mobile station;

a check is carried out to establish whether the mobile station is located in a special area,

the location data is stored in memory for said time interval of predetermined length if the mobile station is in a special area,

a compensation record associated with a call started from the mobile station is generated during the call if the location data has been stored in memory, the information placed in said compensation record comprising at least the location data and data identifying the call,

the compensation record is transmitted to the mobile telephone network.

7. Procedure as defined in claim 6, characterised in that, when the identifier data is stored in memory, information indicating that the mobile station is in a special area is shown on the display of the mobile station.

8. Procedure as defined in claim 6, characterised in that the length of the predetermined time interval is substantially longer than the interval at which the mobile station decodes the signal of the strongest broadcast channel.

9. Procedure as defined in claim 6, characterised in that the special area comprises at least one cell and the list of special areas contains the identifiers of the cells in the special areas.

10. Procedure as defined in claim 6, characterised in that the compensation record is sent during the call.

11. Procedure as defined in claim 6, characterised in that a plurality of compensation records are collected into a batch and the batch is sent to the mobile telephone network.

12. Procedure as defined in claim 6, characterised in that the call data records generated by the mobile switching centre are compared

with the compensation records sent by the mobile station and when, based on the data identifying the call, records corresponding to each other are found, the price of the call is calculated on the basis of the rate set for the special area specified by the background record.

13. Procedure as defined in claim 6, characterised in that the list of special areas is stored in the Subscriber Identity Module.

10 14. Cellular mobile telephone system, which comprises

a mobile switching centre,

a plurality of base transceiver stations, each of which keeps sending its own identifier data in its broadcast channel,

15 mobile stations which consist of a mobile equipment (ME) and a subscriber identity module mounted in it and which order the broadcast channels received from different base transceiver stations according to signal strength and decode at least from the strongest broadcast channel the identifier data sent by the base transceiver station,

20 and in which system at least one special area has been formed and a special charging rate has been set for calls made from such an area, and

25 characterised in that the mobile station contains a list containing data regarding the special areas, and a locator object which

determines the location of the mobile station at time intervals of predetermined length and compares the resulting location data with the list,

30 stores the location data in memory for said time interval of predetermined length if it is comprised in the list,

35 during a call started from a mobile telephone, generates a compensation record associated with the call if the location data is currently stored in

memory and places in the compensation record at least the location data and data identifying the call and sends the compensation record to the mobile telephone network,

5           and that the system contains a billing object, which compares the compensation records with the call data records generated by the mobile switching centre and, when the call identifying data in said records correspond to each other, generates a call  
10 charge using the rate set for the special area indicated in the compensation record.

15           15. System as defined in claim 14, characterised in that the locator object is located in the subscriber identity module (SIM) and the billing object is located in conjunction with a billing centre.

20           16. System as defined in claim 14, characterised in that the interface between the mobile equipment and the subscriber identity module is consistent with GSM system specification 11.14.

25           17. System as defined in claim 16, characterised in that the locator object sends to the mobile equipment a Provide Local Information message at time intervals of predetermined length, and in response to a Terminal Response return message the locator object checks whether the decoded identifier data is included in the list.

30           18. System as defined in claim 17, characterised in that, when the identifier data is included in the list, the locator object sends to the mobile equipment a Display Text message, in response to which the mobile equipment displays the identifier data on its display screen.

35           19. System as defined in claim 14, characterised in that, in response to a message sent to the subscriber identity module (SIM) indicating es-

tablishment of a speech connection, the locator object generates a compensation record.

20. System as defined in claim 14, c h a r -  
a c t e r i s e d in that the locator object sends to  
5 the mobile equipment a Send Short Message message, in  
response to which the mobile equipment sends the com-  
pensation record to the billing object.

21. System as defined in claim 14, c h a r -  
a c t e r i s e d in that the locator object sends to  
10 the mobile equipment a Send USSD message, in response  
to which the mobile equipment sends the compensation  
record to the billing object.

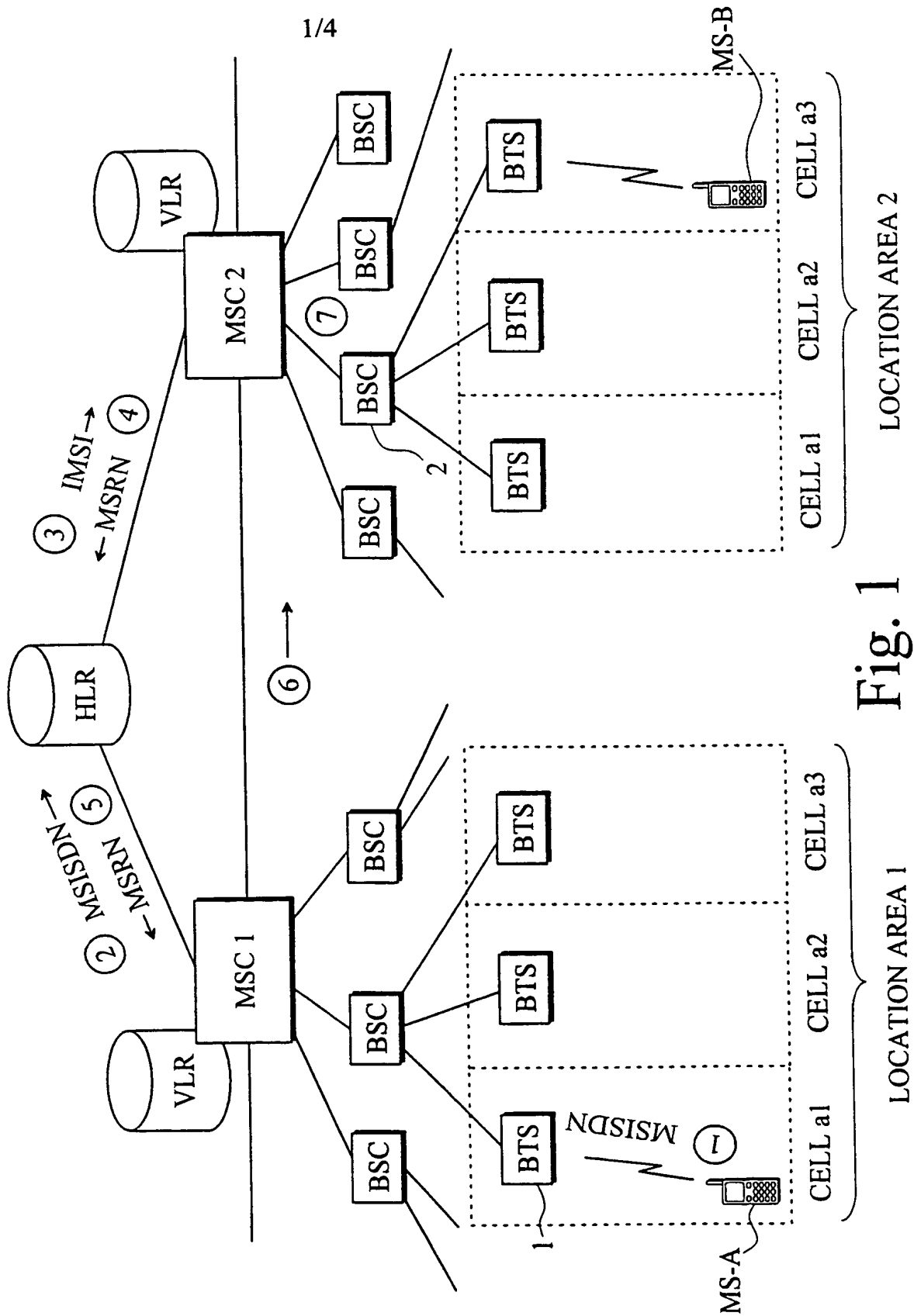


Fig. 1

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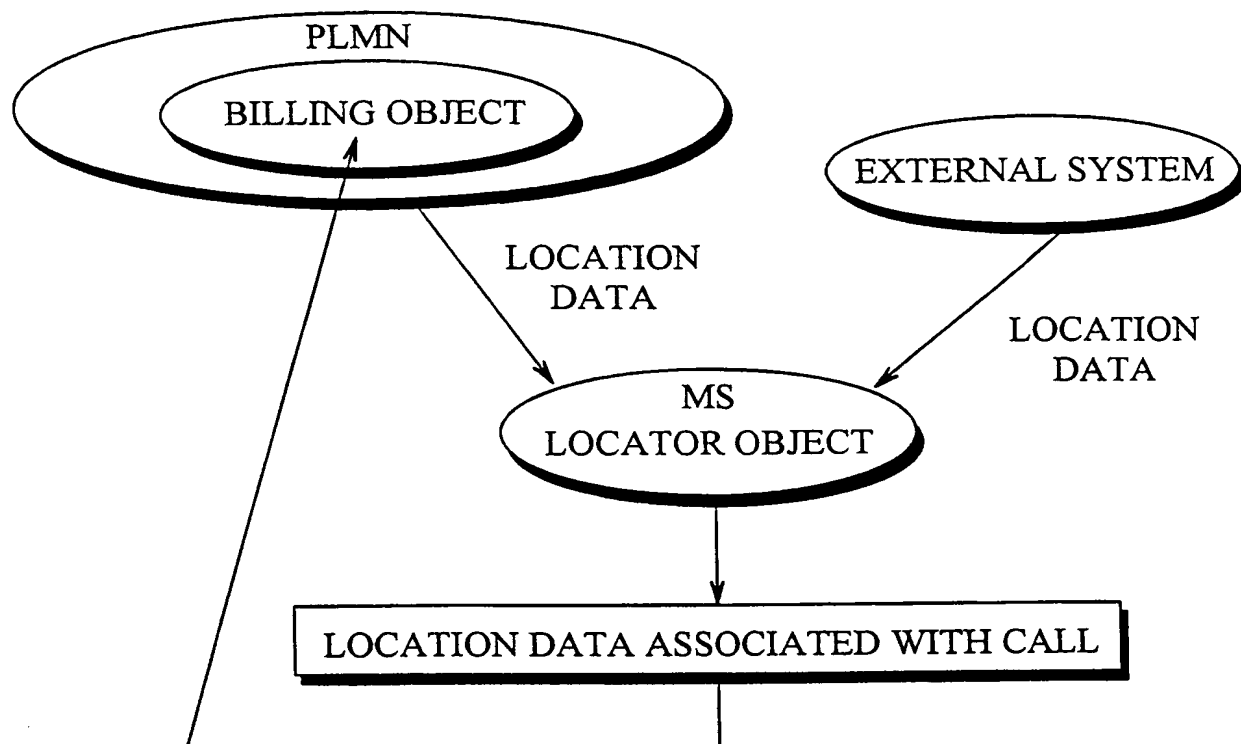
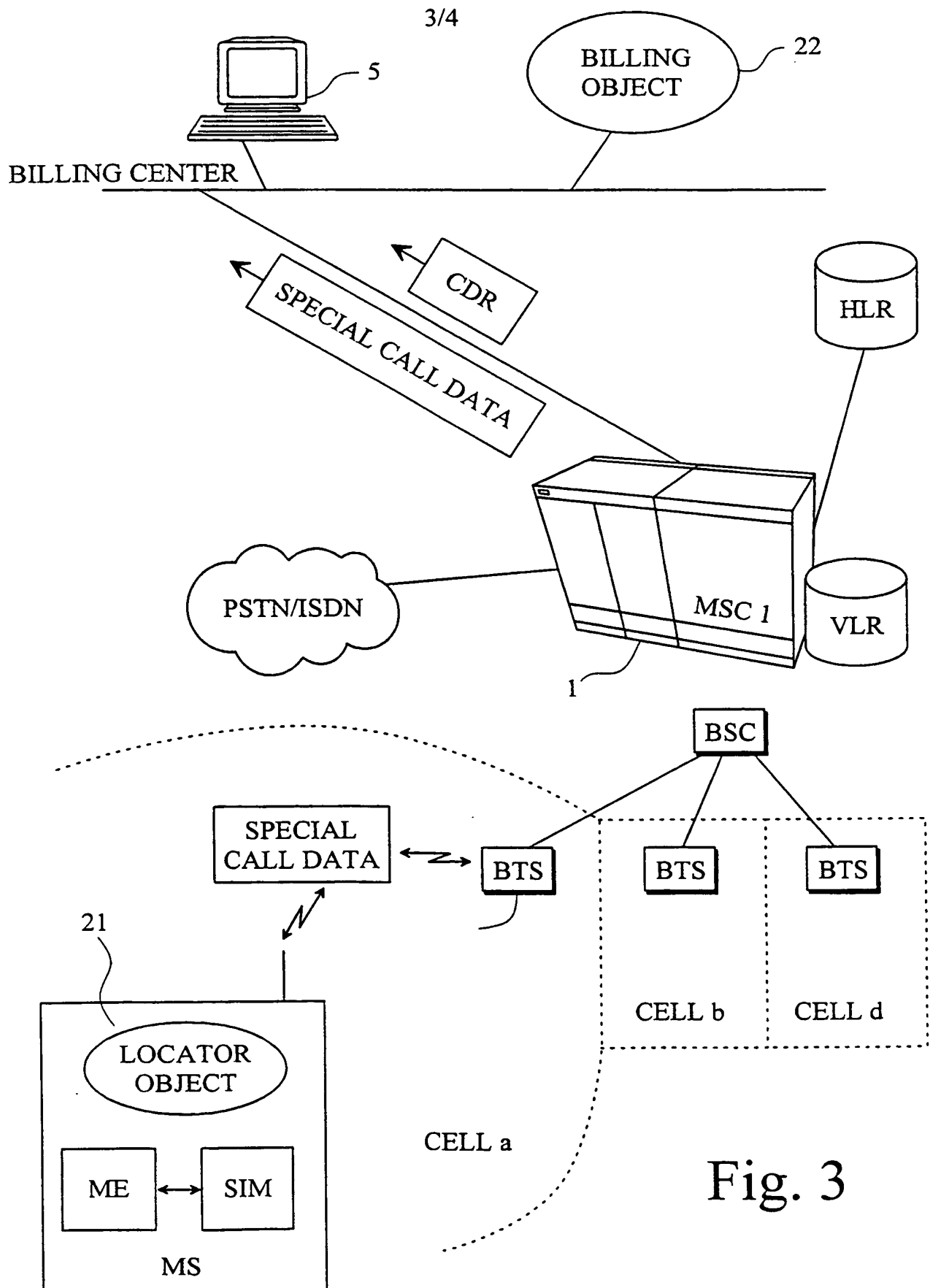


Fig. 2



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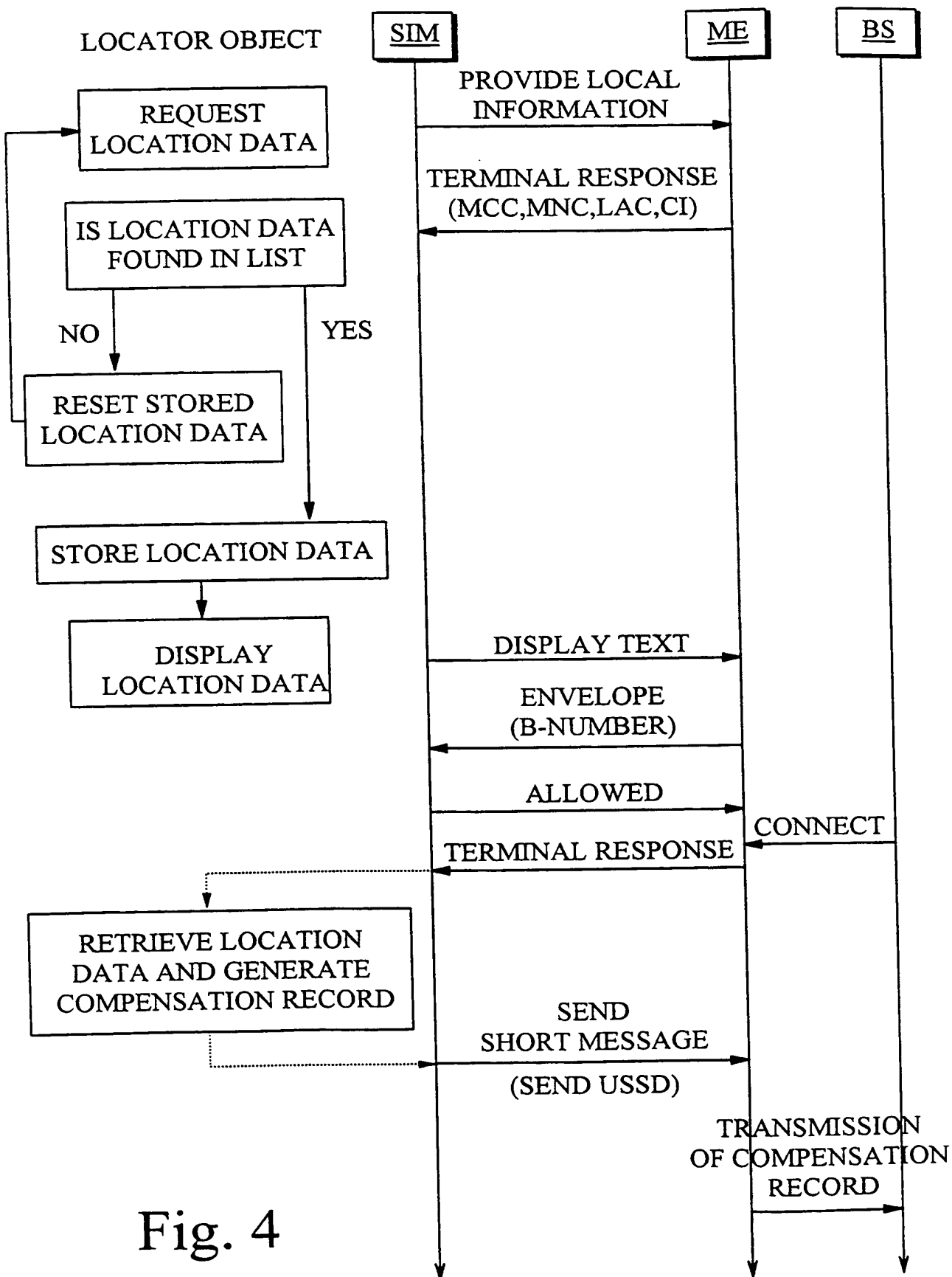


Fig. 4

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 98/00515

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04Q 7/22, H04M 15/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04Q, H04M, G01S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EDOC

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	EP 0734144 A2 (SIEMENS AKTIENGESSELLSCHAFT), 25 Sept 1996 (25.09.96), column 3, line 5 - column 5, line 9, figure 3, abstract --	1-21
A	WO 9620570 A1 (NOKIA TELECOMMUNICATIONS OY), 4 July 1996 (04.07.96), cited in the application --	1-21



Further documents are listed in the continuation of Box C.



See patent family annex.

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

2 November 1998

Date of mailing of the international search report

05-11-1998

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# INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 98/00515

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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05/10/98

International application No.

PCT/FI 98/00515

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